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Kazuya ODA et al.

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Art Unit: 2622

For: IMAGING APPARATUS IN WHICH TYPE OF LIGHT SOURCE IS DISCRIMINATED TO CORRECTLY ADJUST WHITE BALANCE

Examiner: G. V. Selby

SUBMISSION OF VERIFIED ENGLISH LANGUAGE TRANSLATION OF PRIORITY DOCUMENT

Commissioner for Patents
P.O. Box 1450
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Sir:

Applicants hereby submit a verified English language translation of Priority document No. 2003-082085 filed in the above-identified application on March 24, 2004.

Dated: September 27, 2007

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Docket No. 1259-0249-0
3-24-

STATUTORY DECLARATION

I, Kazuyuki NAKAI, of Taiyo Seimei Otsuka Building 3F, 2-25-1, Kitaotsuka, Toshimaku, Tokyo, 170-0004, Japan, do solemnly and sincerely declare as follows:

I am well acquainted with the English and Japanese languages.

The attached translation is true into the English language of the accompanying certified copy of the document filed in the name of Fuji Photo Film Co., Ltd., in the Japanese Patent Office on 25 March 2003, in respect to an application for Patent.

This 28th day of August 2007,

Kaz. Nakai

Kazuyuki NAKAI

JAPAN PATENT OFFICE

This is to certify that the annexed is a true copy of the following application as filed with this Office.

Date of Application:	25 March 2003
Application Number:	2003-082085
Applicant(s):	Fuji Photo Film Co., Ltd.

29 August 2003

Commissioner,

Patent Office Yasuo IMAI (official seal)

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[PAID AMOUNT] 21,000

[LIST OF FILED DOCUMENTS]

[TITLE]	Specification	1
[TITLE]	Drawings	1
[TITLE]	Abstract	1

[PROOF] Wanted

[TITLE OF DOCUMENT] Specification

[TITLE OF THE INVENTION] Imaging apparatus

[SCOPE OF CLAIMS]

[CLAIM 1] An imaging apparatus characterized in comprising an image sensor for receiving subject light coming through a color filter with a main photosensitive portion and a sub photosensitive portion different in spectral characteristic from said main photosensitive portion so as to convert said subject light into image signals, and a discrimination section for discriminating a kind of an illumination light source by comparing said image signals from said main photosensitive portion and from said sub photosensitive portion.

[CLAIM 2] The imaging apparatus of claim 1, wherein said color filter on said main photosensitive portion is thicker or thinner than said color filter on said sub photosensitive portion.

[DESCRIPTION OF THE INVENTION]

[0001]

[TECHNICAL FIELD]

The present invention relates to an imaging apparatus.

[0002]

[BACKGROUND ART]

Digital still cameras, image input devices, and such imaging apparatus are used under various kinds of illumination light sources having different spectral characteristics, such as a tungsten light source, a fluorescent lamp and daylight, and

therefore they are given a mechanism to adjust white balance.

[0003]

The white balance adjustment is made by setting gains of R, G and B in such a way that a white subject photographed under a light source becomes achromatic. For example, a common white balance adjustment for the digital still cameras starts with comparing output levels of the R, G and B image signals from an image sensor to roughly estimate a spectral characteristic of the illumination light source, utilizing the fact that R, G and B photosensitive elements have different spectral characteristics. Then, a most appropriate one of spectral characteristic patterns, prepared for each of such illumination light sources as the tungsten light source, the fluorescent lamp and the daylight, is selected and the gains of R, G and B are set according to this selected spectral characteristic pattern.

[0004]

There is an imaging apparatus that uses an image sensor having main photosensitive portions of relatively large dimension and sub photosensitive portions of relatively small dimension. This type of imaging apparatus has a merit of producing a high-quality photographed image by taking out the image signals separately from the main photosensitive portion and the sub photosensitive portion and then interpolating the image signal of the main photosensitive portion with the image signal of the sub photosensitive portion. For example, a sensitivity difference between the main and the sub photosensitive portions can be used for a interpolation process to widen a dynamic range.

[0005]

[PROBLEMS TO BE SOLVED BY THE INVENTION]

While the conventional method to estimate the spectral characteristic of the illumination light source based on the output levels of the R, G and B image signals from the image sensor allows to roughly distinguish the kind of illumination light source, such as between the tungsten light source and the fluorescent lamp, it hardly allows to minutely discriminate the spectral characteristic differences among the illumination light sources of the same kind. Especially, the spectral characteristic of the fluorescent lamp differs from product to product, and the prepared spectral characteristic pattern of the fluorescent lamp in the imaging apparatus may be different substantially from the actual spectral characteristic of the fluorescent lamp used in the photography. This causes a problem that prevents correct white balance adjustment.

[0006]

Additionally, as for the imaging apparatus using the image sensor with the relatively large main photosensitive portions and the relatively small sub photosensitive portions, the main and the sub photosensitive portions usually have the same spectral characteristic, and accuracy of light source discrimination is therefore about the same as that achieved by the imaging apparatus using the image sensor with one type of photosensitive portions.

[0007]

Created in view of the above problems, the present invention

intends to provide an imaging apparatus capable of improving accuracy of illumination light source discrimination to enable correct white balance adjustment.

[0008]

[MEANS FOR SOLVING THE PROBLEMS]

In order to achieve the above intention, an imaging apparatus according to the present invention includes an image sensor for receiving subject light, coming through a color filter, with a main photosensitive portion and a sub photosensitive portion different in spectral characteristic from the main photosensitive portion so as to convert the subject light into image signals, and a discrimination section for discriminating a kind of an illumination light source by comparing the image signals from the main photosensitive portion and from the sub photosensitive portion.

[0009]

It is preferred to make the color filter on the main photosensitive portion thicker or thinner than the color filter on the sub photosensitive portion.

[0010]

[EMBODIEMENTS OF THE INVENTION]

In FIG. 1, a digital still camera 1 is equipped, on the front surface thereof, with a lens barrel 3 holding a taking lens 2, an optical viewfinder 4, and on the top surface, a pop-up flash emitter 5 and a function dial 6. The flash emitter 5 pops up in response to an operation of a pop-up button 7 on a camera lateral surface, and is manually put back to a concealed

position. The function dial 6 is operated, during focus adjustment and focus adjustment, to switch between manual setting and automatic setting which adapts to various predetermined photography patterns of, for example, long-distance, short-distance and indoor photography. A release button 8 is located in the center of the function dial 6.

[0011]

As shown in FIG. 2, a rear surface of the digital still camera 1 is provided with an operator panel 10 having plural switch buttons arranged thereon and a full-color liquid crystal display 11. Disposed on the operator panel 10 is a mode selector lever 12 to switch between a photography mode and a reproduction mode. The liquid crystal display 11 functions as an electric viewfinder, in the photography mode, to display the image of a photographic subject while it displays the reproduction of a photographed image in the reproduction mode. A cross key 13 is operated for manual exposure adjustment and image resolution setting, and these adjustment and setting can be viewed on a reflective monochrome liquid crystal panel 14.

[0012]

FIG. 3 and FIG. 4 are a plan view and a cross section view both schematically illustrating an image sensor in the imaging apparatus of the present invention. As shown in FIG. 3, a CCD 20 has a pixel area in which plural pixels 21 are arranged in an array of rows and columns, and each pixel 21 has a main photosensitive portion 22 and a sub photosensitive portion 23.

The pixels 21 are disposed on every other rows in a column and on every other columns in a row, forming a honeycomb structure.

[0013]

Each pixel 21 is connected to transfer electrodes indicated as V1s - V4m, from top to bottom in the drawing. These transfer electrodes are connected to vertical charge transfer paths (VCCD) 24 shown in FIG. 4, and these VCCD 24 are connected to a not shown horizontal charge transfer path (HCCD). An image signal, taken out through the transfer electrode, is transferred in the VCCD 24 and the HCCD, and output from the CCD 20, and then applied various signal processing to become a photographed image.

[0014]

The image signal is read out firstly from the main photosensitive portion 22, and then from the sub photosensitive portion 23. After the exposure of the pixels 21, a readout gate pulse is applied to the transfer electrodes V1m, V2m, V3m and V4m to read out the image signals of the main photosensitive portions 22, which are transferred through the VCCD 24 and the HCCD and output from the CCD 20. After the read-out of the image signals of the main photosensitive portions 22, a readout gate pulse is applied to the transfer electrodes V1s, V2s, V3s and V4s to read out the image signals of the sub photosensitive portions 23, which are transferred through the VCCD 24 and the HCCD and output from the CCD 20.

[0015]

As shown in FIG. 4, the CCD 20 includes an n-type

semiconductor substrate 26 and an overlying p-type well 27, on which the main photosensitive portions 22, the sub photosensitive portions 23 and the VCCDs 24 are formed. Additionally, channel stops 28 are provided between each of the main photosensitive portions 22, the sub photosensitive portions 23 and the VCCD 24 to electrically separate these elements.

[0016]

Formed above the transfer electrodes V1s, V1m is a light-shielding film 29, which keeps the VCCD 24 out of light to prevent photoelectrical conversion of subject light in the VCCD 24. A first color filter 31 and a micro-lens 32 are provided above the main photosensitive portion 22 and the sub photosensitive portion 23, across a planarizing layer 30.

[0017]

Provided further above the sub photosensitive portion 23 is a second color filter 33 of the same color as the first color filter 31. In this manner, the thickness of the color filter is changed above the main photosensitive portion 22 and above the sub photosensitive portion 23, so that the subject light on the main photosensitive portion 22 can have a different spectral characteristic from the subject light on the sub photosensitive portion 23.

[0018]

FIG. 5 illustrates an example of the spectral characteristics of the main and the sub photosensitive portions. The spectral characteristic of the main photosensitive portion 22 that

receives the subject light coming through the first color filter 31 is shown with symbols, Bm for a blue region, Gm for a green region, and Rm for a red region. While on the other hand, the spectral characteristic of the sub photosensitive portion 23 that receives the subject light coming through the first and the second color filters 31, 33 is shown with symbols, Bs for the blue region, Gs for the green region, and Rs for the red region.

[0019]

When a half-bandwidth of the spectral characteristic resides within a wave-length range of the light on each photosensitive portion, the main photosensitive portion 22 and the sub photosensitive portion 23 have different light receiving ranges for any of R, G and B colors. In the drawing, the half-bandwidths of Bm, Gm and Rm are indicated as DBm, DGm and DRm respectively, and the half-bandwidths of Bs, Gs and Rs are also indicated as DBs, DGs and DRs respectively. In this drawing, 500nm wavelength light is received by the main photosensitive portions 22 in the blue and green regions because it resides within the light receiving rages of DBm and DGm, but this light is not received by the sub photosensitive portions because it does not reside within the light receiving rages of DBs and DGs. Similarly, 600nm wavelength light is received by the main photosensitive portions 22 in the green and red regions because it resides within the light receiving rages of DGm and DRm, but this light is not received by the sub photosensitive portions because it does not reside within the light receiving rages of DGs and DRs.

[0020]

FIG. 6 illustrates the spectral characteristic of a fluorescent lamp. The fluorescent lamps have one or more bright line spectrums at certain wavelengths. In the drawing, a spectral characteristic LF indicates that this fluorescent lamp has bright line spectrums at 500nm and 600nm wavelengths.

[0021]

When a photography is taken under this fluorescent lamp, the signal levels are significantly different between the main photosensitive portion 22 that reacts the 500nm and 600nm wavelength, where the bright line spectrums of this fluorescent lamp occur, and the sub photosensitive portion 23 that does not react the 500nm and 600nm wavelength. It is therefore possible to discriminate the type of fluorescent lamps by comparing the image signals from the main photosensitive portion 22 and from the sub photosensitive portion 23.

[0022]

Especially, the type of the fluorescent lamps, whose spectral characteristics vary from type to type, can be discriminated correctly by detecting at which wavelength the bright line spectrum occurs. As for the various light sources other than the fluorescent lamps, their types can also be discriminated precisely by comparing the image signals from the main photosensitive portion 22 and from the sub photosensitive portion 23.

[0023]

FIG. 7 illustrates image signal processing process. When a

photographing operation is made on an operating section 40 which includes the function dial 6, the release button 8, the operator panel 10 and so on, a CPU 41 controls a driver 42 to activate an optical system 43 composed of the taking lens 3, the lens barrel 3 and so on to take a photography.

[0024]

After the photography, the CPU 41 activates a timing generator 44 through a driver 45 to apply a readout gate pulse to the transfer electrodes V1m, V2m, V3m and V4m of the CCD 20. IN response to the readout gate pulse, electric charges of the main photosensitive portions 22 are taken out from the CCD 20 through the VCCD 24 and the HCCD, and transferred to a CDS/GCA section 46. When the image signals of all the main photosensitive portions 22 are taken out, another readout gate pulse is applied to the transfer electrodes V1s, V2s, V3s and V4s, so that the image signals of the sub photosensitive portions 23 are taken out in the same manner and transferred from the CCD 20 to the CDS/GCA section 46.

[0025]

In the CDS/GCA section 46, noises are removed from the image signals by a correlated double sampling operation, and the size of each image signal is optimized by a gain control amplifier. The image signal, after this CDS/GCA processing, is converted into a digital signal in an A/D converter 47.

[0026]

The image signal that has been converted into a digital form in the A/D converter 47 is sent to a signal processor 48. As

described in detail below, the image processor 48 performs a comparison calculation between the images from the main photosensitive portion 22 and the sub photosensitive portion 23 to adjust the white balance during photometry and, when a photography is taken, it applies such processing as dynamic range widening to the photographed image if necessary. After the various processing in the image processor 48, the finished image signal is displayed on the liquid crystal display 11, and also stored as image data in a recording medium 49. Note that it is possible to create an optimal condition for each signal processing by generating pulse signals, from the timing generator 44, in synchronize with a reference clock during all the image processing from image signal readout from the CCD 20 to the interpolation process in the signal processor 48.

[0027]

FIG. 8 illustrates the image processing process in the image processor 48. The image signal, taken out from the CCD 20 during photometry, is converted by the A/D converter 47 into a digital signal, which is then sent to a WB gain determination section 50. By comparing integrated values of the R, B and G signal levels of the main photosensitive portion 22 and of the sub photosensitive portion 23, the WB gain determination section 50 discriminates the kind of the illumination light source, and determines gain correction coefficients for R, B and G colors to the main photosensitive portion 22 and the sub photosensitive portion 23, according to the kind of the illumination light source. For example, when an integrated value M of the signal

level of the main photosensitive portion = an integrated value S of the signal level of the sub photosensitive portion × a sensitivity coefficient α , the light source will be discriminated as a normal (or familiar) light, and when the integrated value M of the signal level of the main photosensitive portion ≠ the integrated value S of the signal level of the sub photosensitive portion × the sensitivity coefficient α , the kind of an unfamiliar light will be discriminated according to the difference of the values. Note that the sensitivity coefficient α depends on such a design factor of the image sensor as a thickness of the color filter.

[0028]

When a photography is taken after the photometry and the determination of the R, G and B gain correction coefficients, the image signals are read out from the main photosensitive portion 22 and the sub photosensitive portion 23, and converted respectively into digital form. The white balance of the image signal from the main photosensitive portion 22 is adjusted in a gain correction section 51a where the gains of R, G and B colors are corrected with the gain correction coefficients determined by the WB gain determination section 50. Similarly, the white balance of the image signal from the sub photosensitive portion 23 is adjusted in a gain correction section 51b where the gains are corrected with the gain correction coefficients determined by the WB gain determination section 50.

[0029]

Out of the gain correction sections 51a, 51b, the image

signals of the main portion 22 and the sub photosensitive portion 23 undergo a gamma correction process in gamma correction sections 52a, 52b respectively, and then they are synthesized on a pixel-by-pixel basis in an image adding section 53. During this period, the dynamic range widening and other processing are performed if necessary. The synthesized photographed image is sent to a multi-correction section 54 where contour correction and color correction are performed. The image is then compressed into a JPEG image in a JPEG compression section 55, and stored in the recording medium 49. This JPEG image is also diminished in an image reduction section 56, and displayed on the liquid crystal display 11. Since the white balance adjustment is properly performed, these finished images have high resolution.

[0030]

In the above embodiment, the spectral characteristic of the subject light is made different on the main photosensitive portion 22 and on the sub photosensitive portion 23 by changing the thickness of the color filters above these portions. However, the present invention is not limited to this, and it is possible to differentiate the spectral characteristic of the subject light on the main and sub photosensitive portions by, for example, as shown in FIG.9, changing the thickness of main and sub photosensitive portions 62, 63 in the optical axis direction.

[0031]

Additionally, in the above embodiment, the thickness of the

color filter is made different above the main and sub photosensitive portions 22, 23 by providing a second color filter 33 above the sub photosensitive portion 23. However, the method to change the color filter thickness is not limited to this, and it is possible to use a single color filter whose thickness is changing partially. While, in the above embodiment, the thickness of the color filter is thicker on the sub photosensitive portion 23 than on the main photosensitive portion 22, the color filter can be thicker on the main photosensitive portion 22 on the contrary.

[0032]

The arrangement of the pixels is not necessary be a honeycomb form, but may be a square matrix from. Furthermore, the image sensor is not limited to the CCD, and other image sensor such as a MOS type image sensor may be used in the present invention.

[0033]

Although the above embodiment is described with the digital still camera, the present invention is not limited to this, but also applicable to image input devices.

[0034]

[EFFECT OF THE INVENTION]

As stated above, according to the present invention, the imaging apparatus is equipped with the image sensor which receives subject light, coming through the color filter, with the main photosensitive portions and the sub photosensitive portions different in spectral characteristic from the main photosensitive portions so as to convert the light into image

signals, and the discrimination section for discriminating a kind of an illumination light source by comparing the image signals from the main photosensitive portion and from the sub photosensitive portion. It is therefore possible to improve the accuracy of illumination light source discrimination, and to make correct white balance adjustment.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[Figure 1]

A front perspective view of a digital still camera according to the present invention.

[Figure 2]

A rear perspective view of the digital still camera.

[Figure 3]

A schematic plan view of an image sensor according to the present invention.

[Figure 4]

A schematic cross-section view of the image sensor.

[Figure 5]

An explanatory view showing an example of spectral characteristics of main and sub photosensitive portions.

[Figure 6]

An explanatory view showing an example of the spectral characteristic of a fluorescent lamp.

[Figure 7]

A block diagram showing a process of an image signal processing.

[Figure 8]

An explanatory view showing a signal processing in a signal processor.

[Figure 9]

A schematic cross-section view of an image sensor according to another embodiment of the present invention.

[DESCRIPTION OF THE REFERENCE NUMBERS]

1 digital still camera

20 CCD

22 main photosensitive portions

23 sub photosensitive portions

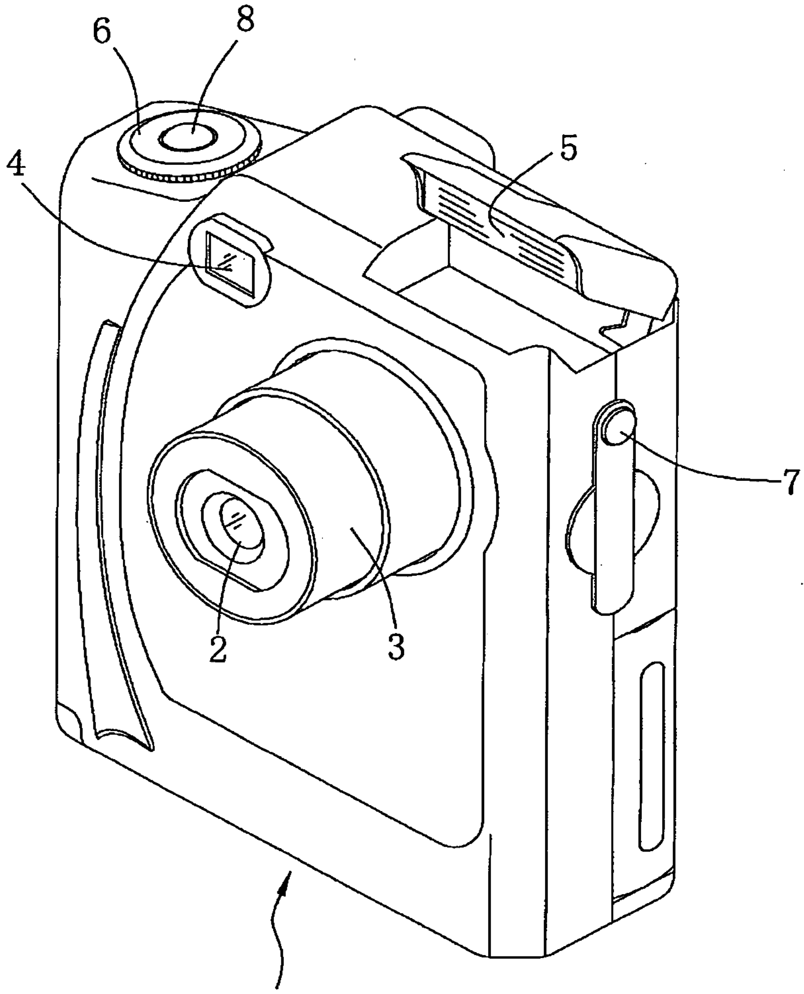
31 first color filter

33 second color filter

50 WB gain determination section

【書類名】DOCU-MENT NAME　図面　DRAWING

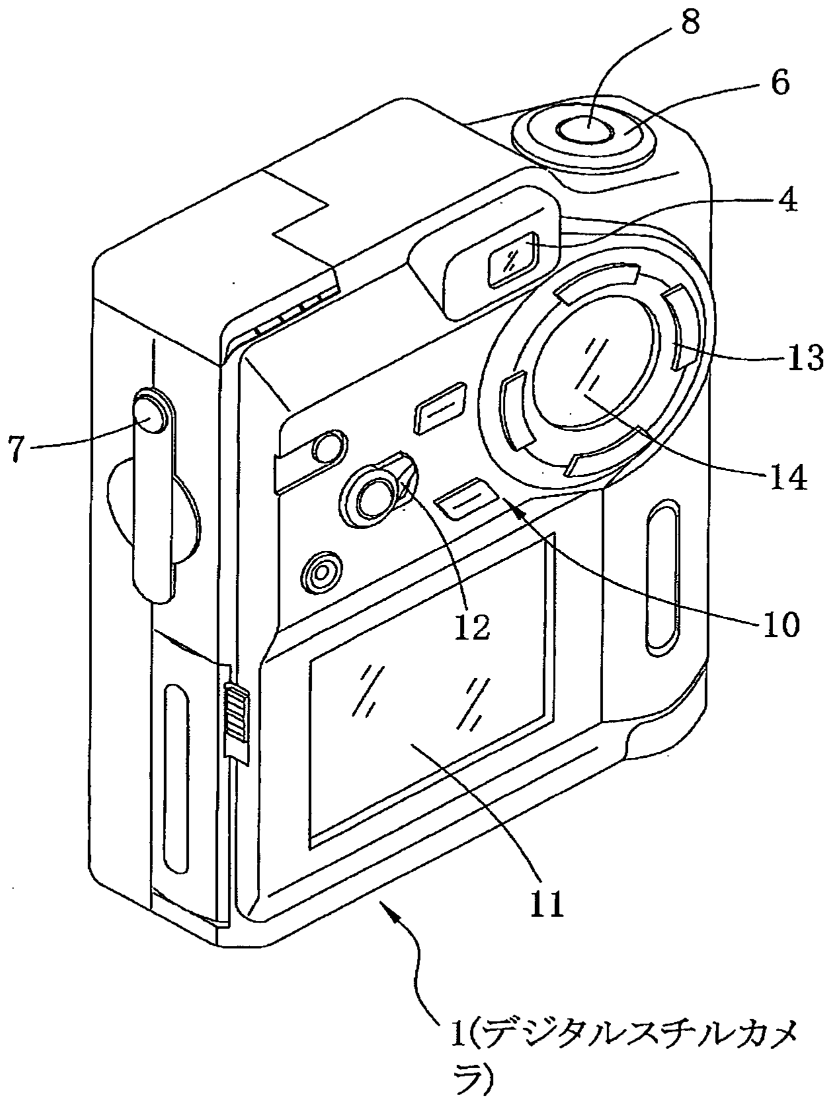
【図１】
FIG. 1



1(デジタルスチルカメラ)
DIGITAL STILL CAMERA

【図２】

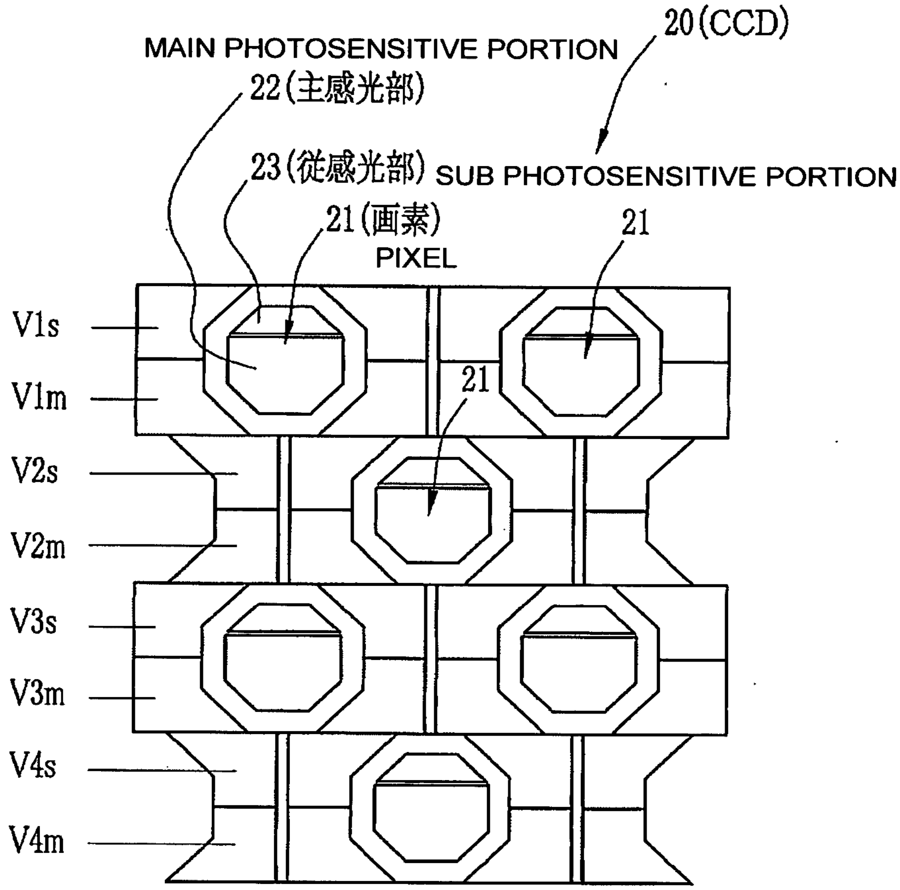
FIG. 2



DIGITAL STILL CAMERA

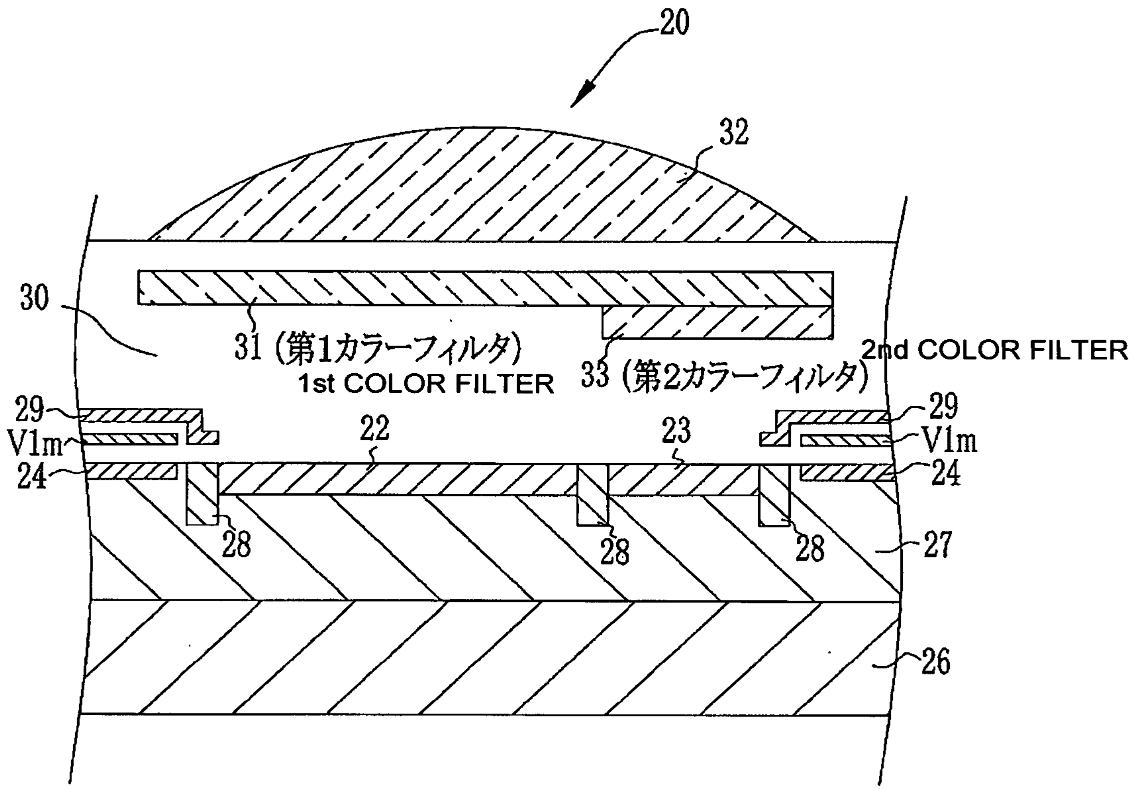
【図３】

FIG. 3

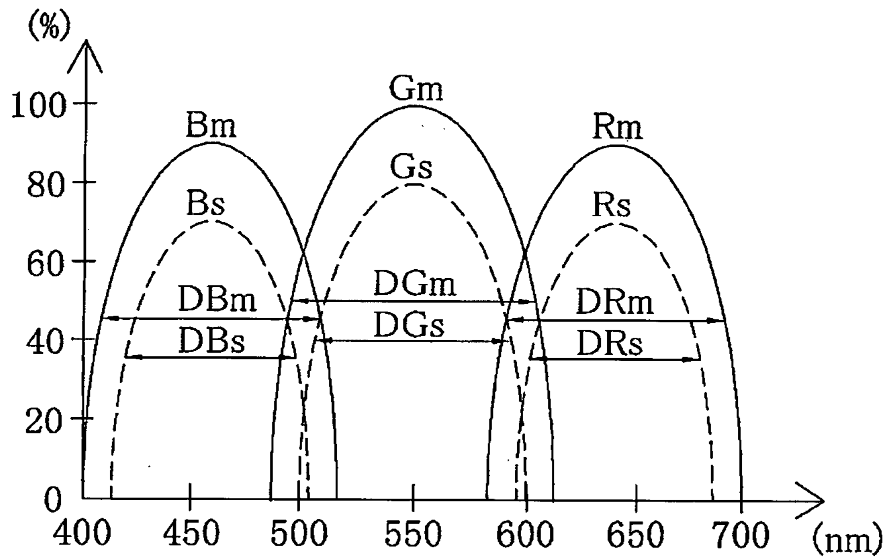

20(CCD)
MAIN PHOTOSENSITIVE PORTION
22(主感光部)
23(従感光部) SUB PHOTOSENSITIVE PORTION
21(画素)
PIXEL
21
21
V1s
V1m
V2s
V2m
V3s
V3m
V4s
V4m

【図４】

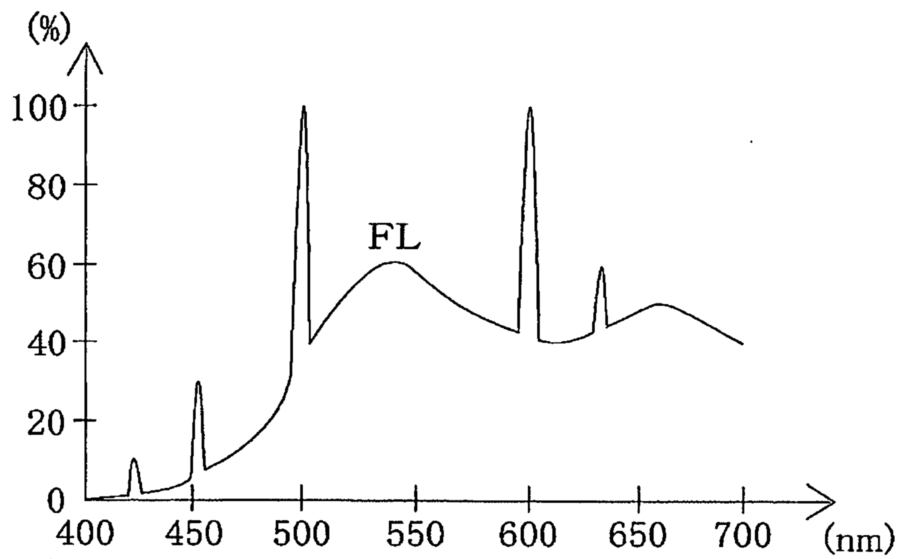
FIG. 4


20
32
30
31 (第1カラーフィルタ)
1st COLOR FILTER
33 (第2カラーフィルタ)
2nd COLOR FILTER
29
V1m
24
22
23
28
27
26

【図５】 FIG. 5

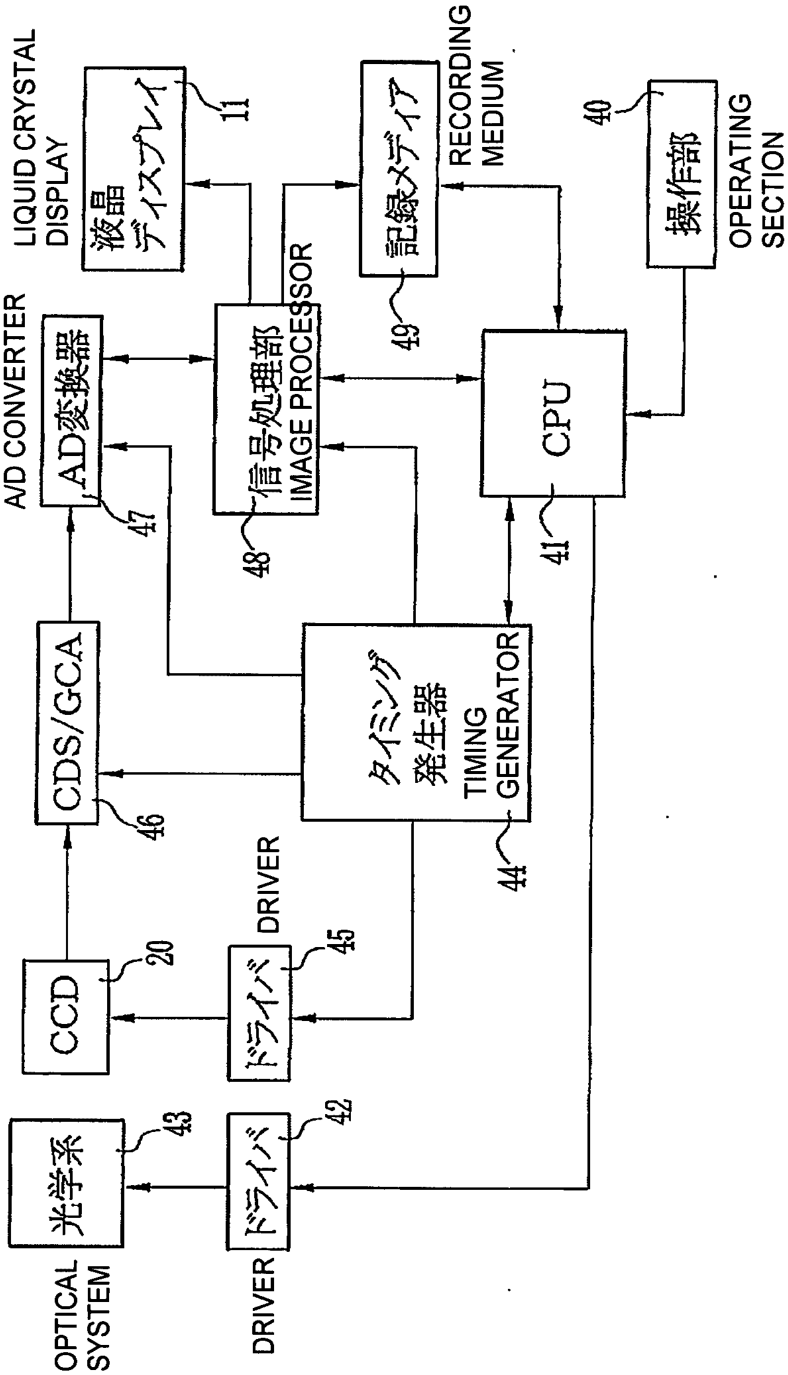


【図６】 FIG. 6



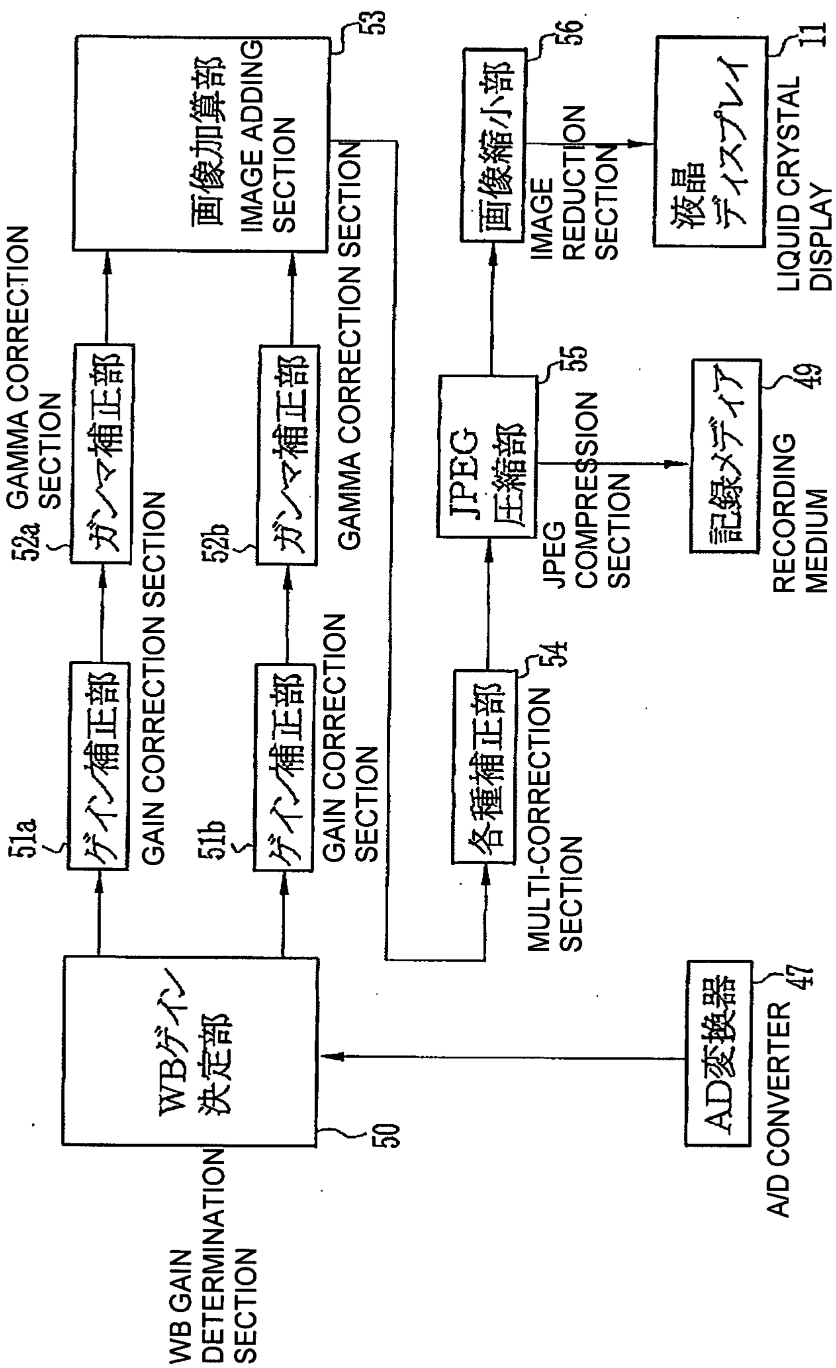
【図７】

FIG. 7


LIQUID CRYSTAL DISPLAY
液晶ディスプレイ
11
RECORDING MEDIUM
記録メディア
49
40
操作部
OPERATING SECTION
A/D CONVERTER
AD変換器
47
信号処理部
IMAGE PROCESSOR
48
CPU
41
CDS/GCA
46
タイミング発生器
TIMING GENERATOR
44
CCD
20
DRIVER
ドライバ
45
光学系
43
OPTICAL SYSTEM
ドライバ
42
DRIVER

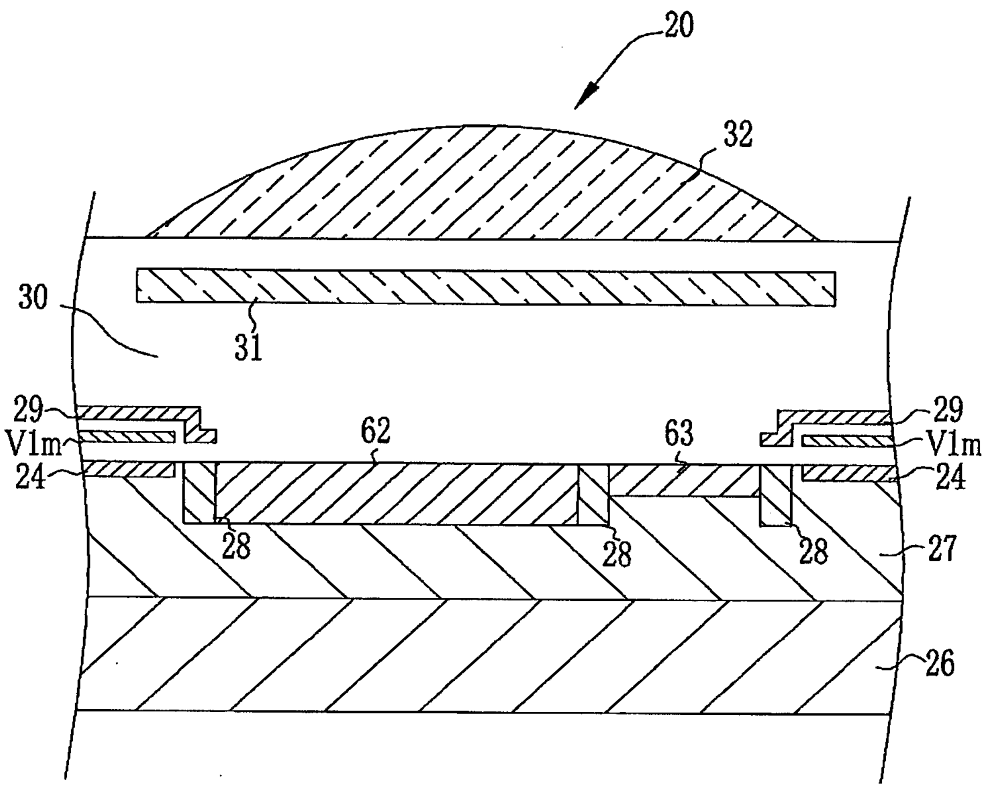
【図８】

FIG. 8


WBゲイン決定部
WB GAIN DETERMINATION SECTION
50
ゲイン補正部
GAIN CORRECTION SECTION
51a
51b
ガンマ補正部
GAMMA CORRECTION SECTION
52a
52b
画像加算部
IMAGE ADDING SECTION
53
各種補正部
MULTI-CORRECTION SECTION
54
JPEG圧縮部
JPEG COMPRESSION SECTION
55
画像縮小部
IMAGE REDUCTION SECTION
56
液晶ディスプレイ
LIQUID CRYSTAL DISPLAY
11
記録メディア
RECORDING MEDIUM
49
AD変換器
A/D CONVERTER
47

【図９】

FIG. 9



[TITLE OF DOCUMENT] Abstract

[ABSTRACT]

[OBJECT] To provide an imaging apparatus capable of improving discrimination accuracy for an illumination light source and adjusting white balance correctly.

[RESOLUTION] A CCD 20 includes an n-type semiconductor substrate 26 and an overlying p-type well 27, on which a main and a sub photosensitive portions 22, 23 are formed. Provided above the main and sub photosensitive portions 22, 23, across a planarizing layer 30, are a first color filter 31 and a micro-lens 32. Provided further on the sub photosensitive portion 23 is a second color filter 33 having the same color as the second color. Since the thickness of the color filter is deferent above the main photosensitive portion 22 and above the sub photosensitive portion 23, the spectral characteristic of subject light varies on the main photosensitive portion 22 and the sub photosensitive portion 23.

[ELECTED FIGURE] Figure 4